Supplementary material

Perchlorates on Mars enhance the bacteriocidal effects of UV light

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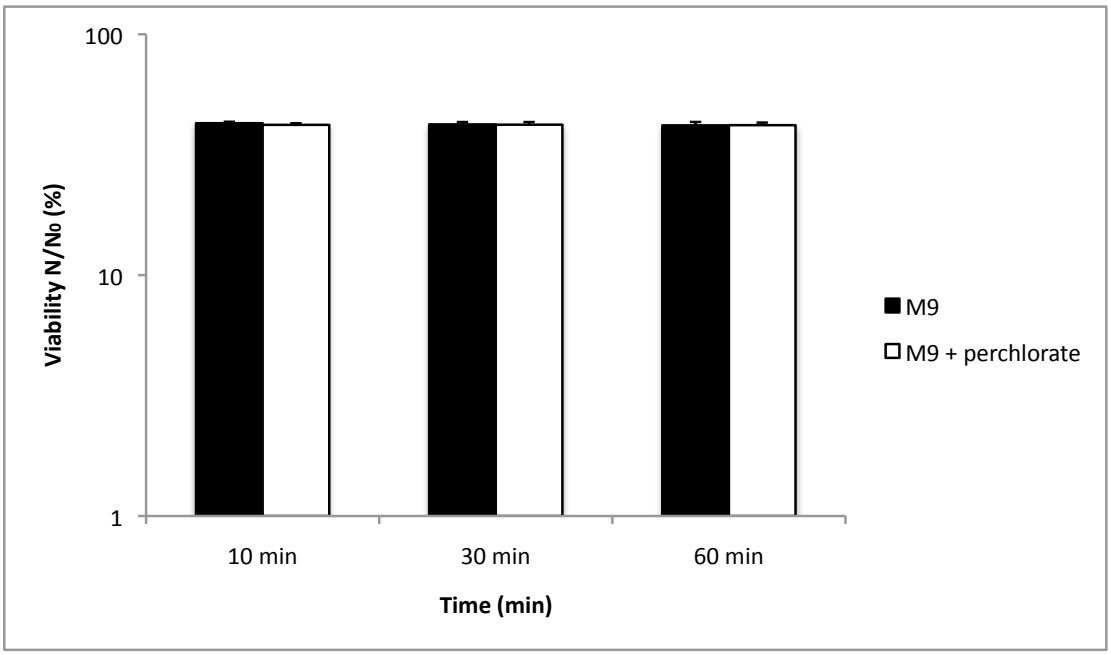
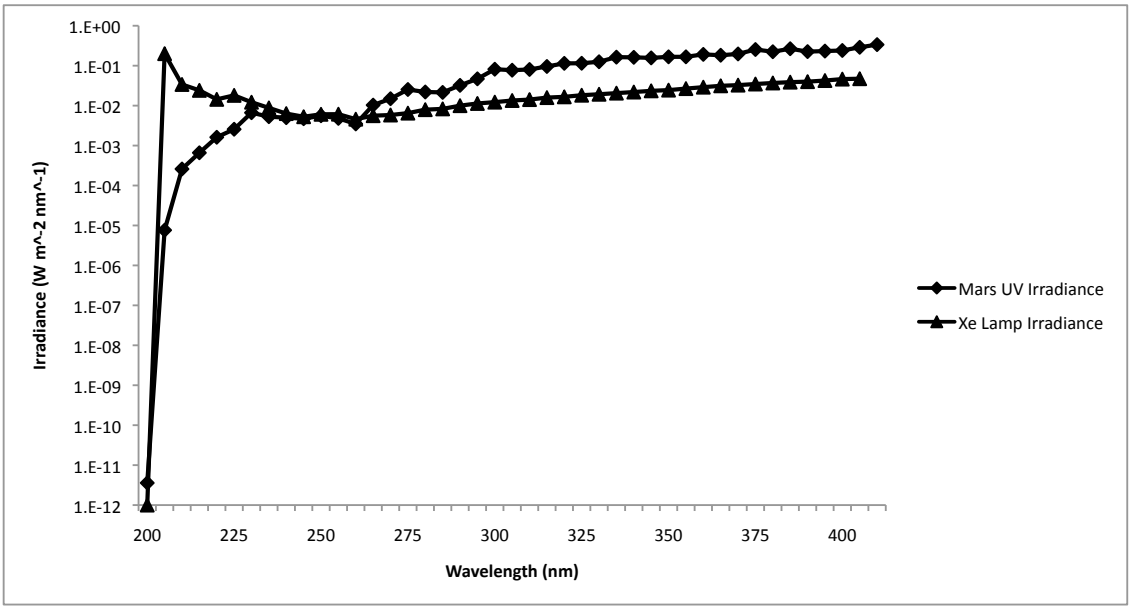
Supplementary Fig. S1: Dark controls for M9 and perchlorate.

Bacillus subtilis in M9 medium, covered to control for light and sampled at given time points. M9 = cells in M9 medium; M9 + perchlorate = cells in M9 containing 0.6 wt% $Mg(ClO_4)_2$. Error bars are + s.d. (n = 3).



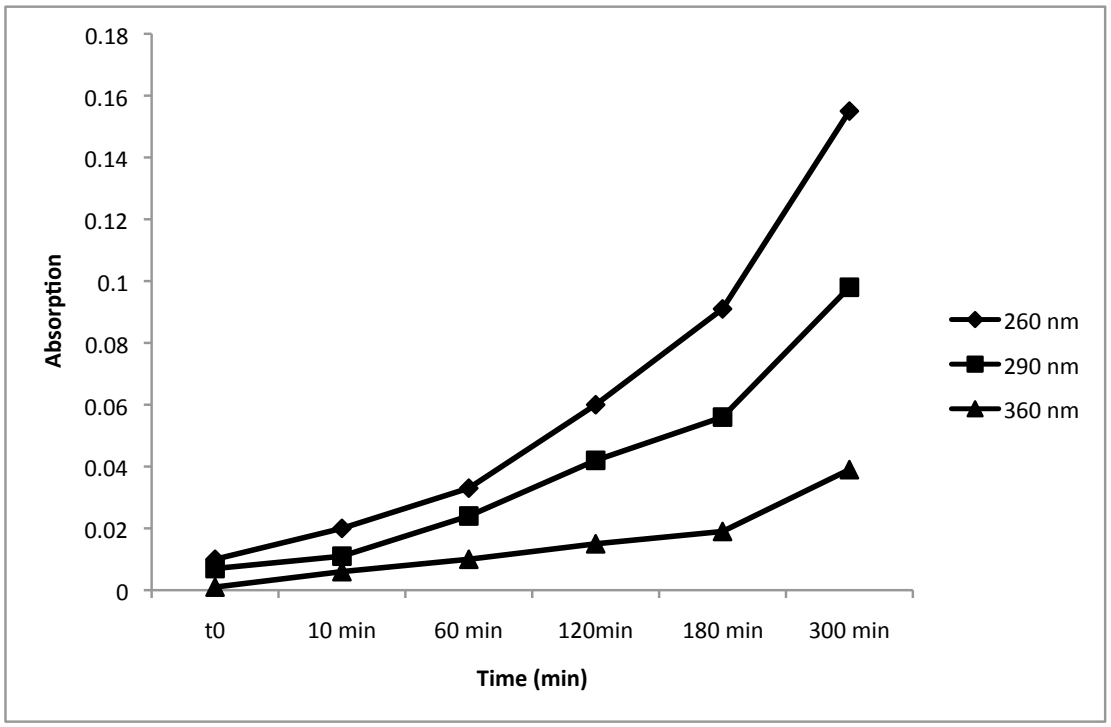
Supplementary Fig. S2: Modelled Mars UV irradiance vs. measured Mars chamber UV irradiance 200-400 nm.

Mars UV irradiance ($mW/m^2/nm$) was calculated using the model from Cockell et al.[1] with following parameters: OD = 1 (τ = 1.0); Sunlight angle 45°. Irradiance from polychromatic Xe lamp was measured in the Mars Chamber[2].



Supplementary Fig. S3: UV spectrophotometric absorbance of irradiated perchlorate: 6 wt% $Mg(ClO_4)_2$ irradiated with UVC.

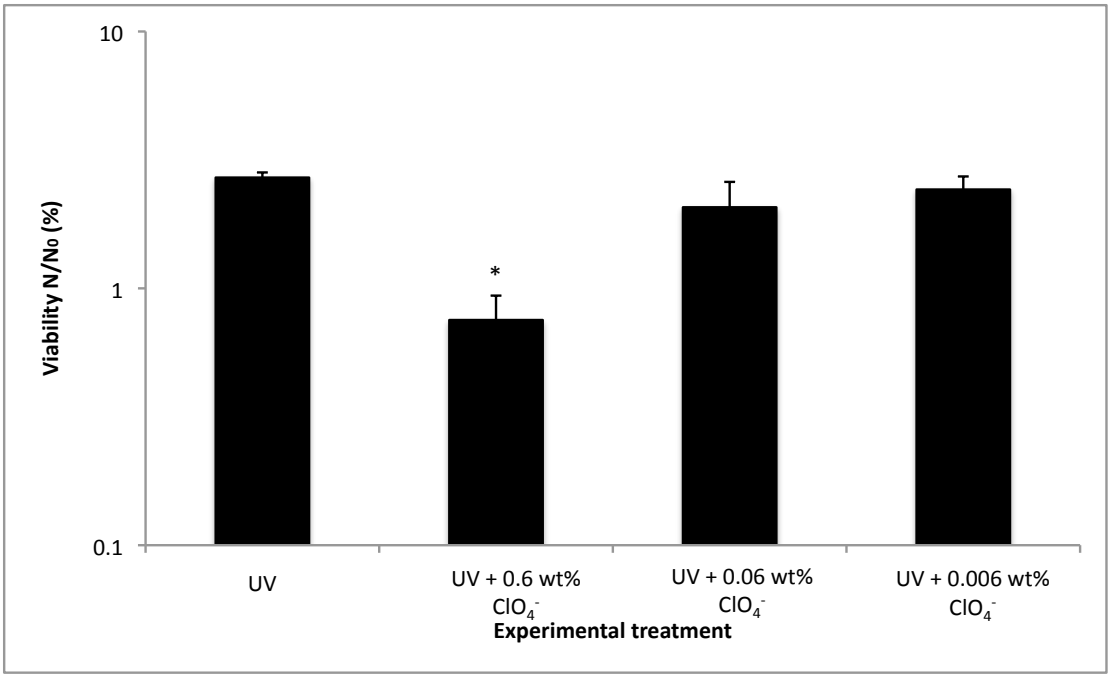
UV-irradiated perchlorate (λ = 254nm) in sterile, distilled water; Absorbance at 260, 290 and 360 nm; Blanks used contained 6 wt% perchlorate.



Supplementary Fig. S4**:** Effects of low concentrations of UVC-irradiated $Mg(ClO_4)_2$ on cell viability, 60 seconds exposure.

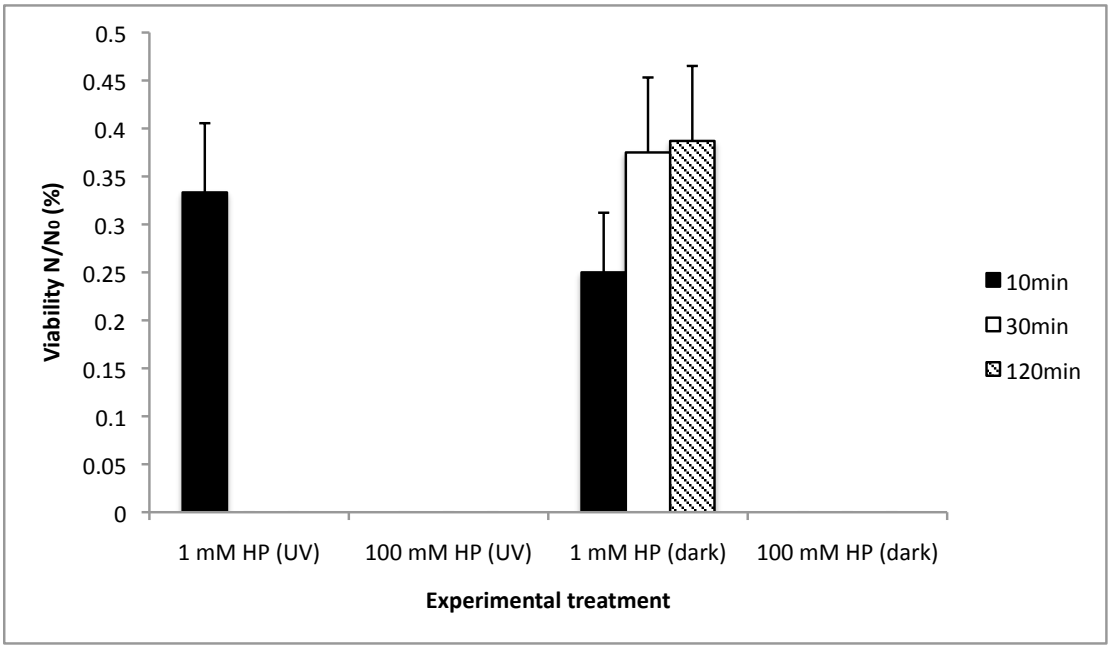
UV = UVC irradiated control; ClO_4- = $Mg(ClO_4)_2$ at given wt%.

$p < 0.05$ was considered statistically significant (*); error bars are + s.d. (n = 3).



Supplementary Fig. S5: Effects of low and high concentrations of hydrogen peroxide on cell viability; irradiated and dark controls.

UV = irradiated with UV (λ = 254 nm); dark = covered samples; HP = hydrogen peroxide at given molarity. Error bars are + s.d. (n = 3).



Supplementary Table S1: Summarized numerical results of viability of irradiated *B. subtilis* cells under various Martian analogue conditions.

Table contains numerical results from figures in the main paper. Results are in the unit N/N_0 [%], with 'N' as the number of surviving cells after a given treatment and 'N_0' is the number of cells in the starting concentration calculated using the average of triplicates. The results for each condition are paired with the results from the respective UV-irradiated control (λ = 254 nm, unless stated) and grouped into shaded or white rows. 'Mg-perchlorate' = $Mg(ClO_4)_2$ at given wt%; 'Ca-perchlorate' = $Ca(ClO_4)_2$ at given wt%; 'Na-perchlorate' = $NaClO_4$ at given wt%; Sulfate = $MgSO_4$ at given wt %; H = 1 g/L Hematite (5 μm grain size); HP = hydrogen peroxide at final concentration of 10 mM; polychromatic UV = 200-400 nm; n.a. = not applicable.

	Irradiation time	
Conditions	30 s	60 s
UV control	1.53	0
UV + 0.6 wt% Mg-perchlorate	0	0
UV control	45.86	22.22
UV + 0.6 wt% Mg-perchlorate in rock analogue	26.67	2.90
UV control	n.a.	0.12
UV + 0.6 wt% Mg-perchlorate, anaerobic liquid system	n.a.	0
UV control	n.a.	8.23
UV + 0.6 wt% Mg-perchlorate, anaerobic rock analogue	n.a.	0.85
UV control	0.36	0.15
UV + 1 wt% Mg-perchlorate	0.003	0
UV + 2.5 wt% Mg-perchlorate	0.003	0

UV + 5 wt% Mg-perchlorate	0	0
UV control	3.93	0
UV + 0.6 wt% Ca-perchlorate	0	0
UV + 0.6 wt% Na-perchlorate	0.09	0
UV control (16 x less irradiance)	5.91	1.45
UV + 0.6 wt% Ca-perchlorate (16 x less irradiance)	7.36	0.54
UV + 0.6 wt% Na-perchlorate (16 x less irradiance)	6.07	0.69
UV control	n.a.	2.70
UV + 30 wt% sulfate	n.a.	2.41
UV + 0.6 wt% Mg-perchlorate + 30 wt% sulfate	n.a.	2.58
UV control	3.34	2.26
UV + H	4.61	3.10
UV + HP	2.33	1.20
UV + 0.6 wt% Mg-perchlorate	2.37	1.39
UV + H + HP	3.36	0.84
UV + H + 0.6 wt% Mg-perchlorate	4.74	1.44
UV + HP + 0.6 wt% Mg-perchlorate	4.08	0.79
UV + H + HP + 0.6 wt% Mg-perchlorate	4.16	0.21
UV control	1.70	1.27
UV + 0.6 wt% Mg-perchlorate at 4°C	3.32	1.69

	1 min	2 min
UV control	1.43	0.09

UV + 0.6 wt% Mg-perchlorate at 4°C	1.31	0.008

	3 min	4 min
UV control	0	0
UV + 0.6 wt% Mg-perchlorate at 4°C	0	0

	10 s
Polychromatic UV control	3.13
Polychromatic UV + 0.6 wt% Mg-perchlorate	0.29

Supplementary references

[1] Cockell. C. *et al.* The ultraviolet environment of Mars: Biological implications past, present, and future. *Icarus* **146,** 343-359 (2000).

[2] Martin D., Cockell C. S. PELS (Planetary Environmental Liquid Simulator): A new type of simulation facility to study extraterrestrial aqueous environments. *Astrobiology* **15,** 111-8 (2015).